New â€˜Nuclear Batteryâ€™ Runs 10 Years, 10 Times More Powerful

May 12 2005

A battery with a lifespan measured in decades is in development at the University of Rochester, as scientists demonstrate a new fabrication method that in its roughest form is already 10 times more efficient than current nuclear batteriesâ€”and has the potential to be nearly 200 times more efficient. The details of the technology, already licensed to BetaBatt Inc., appears in todayâ€™s issue of Advanced Materials.

â€œOur society is placing ever-higher demands for power from all kinds of devices,â€? says Philippe Fauchet, professor of electrical and computer engineering at the University of Rochester and co-author of the research. â€œFor 50 years, people have been investigating converting simple nuclear decay into usable energy, but the yields were always too low. Weâ€™ve found a way to make the interaction much more efficient, and we hope these findings will lead to a new kind of battery that can pump out energy for years.â€?

The technology is geared toward applications where power is needed in inaccessible places or under extreme conditions. Since the battery should be able to run reliably for more than 10 years without recharge or replacement, it would be perfect for medical devices like pacemakers, implanted defibrillators, or other implanted devices that would otherwise require surgery to replace or repair. Likewise, deep-space probes or deep-sea sensors, which are beyond the reach of repair, also would benefit from such technology.

Betavoltaics, the method that the new battery uses, has been around for half a century, but its usefulness was limited due to its low energy yields. The new battery technology makes its successful gains by dramatically increasing the surface area where the current is produced. Instead of attempting to invent new, more reactive materials, Fauchetâ€™s team focused on turning the regular materialâ€™s flat surface into a three-dimensional one.

Similar to the way solar panels work by catching photons from the sun and turning them into current, the science of betavoltaics uses silicon to capture electrons emitted from a radioactive gas, such as tritium, to form a current. As the electrons strike a special pair of layers called a â€œp-n junction,â€? a current results. Whatâ€™s held these batteries back is the fact that so little current is generatedâ€”much less than a conventional solar cell. Part of the problem is that as particles in the tritium gas decay, half of them shoot out in a direction that misses the silicon altogether. Itâ€™s analogous to the sunâ€™s rays pouring down onto the ground, but most of the rays are emitted from the sun in every direction other than at the Earth. Fauchet decided that to catch more of the radioactive decay, it would be best not to use a flat collecting surface of silicon, but one with deep pits.

A layer of silicon riddled with pits, each of which would fill with the radioactive tritium gas, would be like dropping the sun into a deep well lined with solar panels. Almost all of the sunâ€™s rays, no matter which way they were emitted, would strike a well wall. Only those rays that fired straight up and out of the well would be lost. With this reasoning, Fauchet devised a method to excavate pits into a microscopic piece of silicon.

The pits, or wells, are only about a micron wide (about four ten-thousandths of an inch), but are more than 40 microns deep. After the wells are â€œdugâ€? with an etching technique, their insides are coated with a material to form a p-n junction just a tenth of a micron thick, which is the best thickness to induce a current. The Advanced Materials paper details how these wells were dug in a random fashion, yielding a 10-fold increase in current over the conventional design. The team is already working on a technique to create and line the wells in a much more uniform, lattice formation that should increase the energy produced by as much as 160-fold over current technology.

â€œOur ultimate design has roughly 160 times the surface area of the conventional, flat design,â€? says Fauchet. â€œWe expect to be able to get an efficiency that very nearly matches, and weâ€™re doing this using standard semiconductor industry fabrication techniques.â€?

Houston-based BetaBatt Inc. has formed to capitalize on the technology, and has recently been awarded a technology commercialization grant by the National Science Foundation (NSF). NSF funded the initial research as well. Collaborators on this research included one of Fauchetâ€™s graduate students, Wei Sun, Nazir Kherani from the University of Toronto, Karl Hirschman from Rochester Institute of Technology, and Larry Gadeken from BetaBatt, Inc.

Citation: New â€˜Nuclear Batteryâ€™ Runs 10 Years, 10 Times More Powerful (2005, May 12) retrieved 20 April 2024 from https://phys.org/news/2005-05-nuclear-battery-years-powerful.html